

Application No.: 10/615,939

Reply to Office Action of: February 6, 2006

BASIS FOR THE AMENDMENT

The claims have been amended to correct minor informalities.

Claim 36 has been added as supported by Claims 1, 2, 5, 9 and 10 as originally filed.

No new matter is believed to have been added by entry of this amendment. Entry and favorable reconsideration are respectfully requested.

Upon entry of this amendment Claims 1-36 will now be active in this application.

Claims 27, 28 and 30-35 stand withdrawn from consideration.

REMARKS

Applicants wish to thank Examiner Jenkins for the helpful discussion on April 19, 2006. Applicants respectfully request reconsideration of the application, as amended, in view of the following remarks.

The present invention as set forth in **Claim 1** provides a process for compacting a green compact, comprising:

applying a higher fatty acid-based lubricant to an inner surface of a die;

filling a raw material powder whose major component is an active metallic element into the die;

compacting the raw material powder by warm pressurizing to make a green compact; and

ejecting the green compact from the die;

whereby the resulting green compact has a high density.

In contrast, JP5071206A and Inculet et al fail to disclose or suggest a process for compacting a green compact in which the raw material powder is compacted by warm pressurizing to make the green compact.

The Examiner has recognized that JP '206 does not disclose compacting the raw material powder by warm pressurizing. Inculet et al think that warm pressing as well as cold pressing of conventional metal powders are equally suitable for the compacting process (col. 5, lines 5-15).

However, superior properties are achieved when using the warm compacting as shown by the Examples in the specification.

When compacting is done at **room temperature** as in the Comparative examples, the green compact density, the relative density of the green compact, the sintered body density, the relative density of the sintered body become small. In addition, large dimensional

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changes before and after sintering occur. Please see the **Table 1** below which is reproduced from page 44 of the specification and **Figures 1-4 and 8 and 9 of the specification**. On the other hand, using the **process according to the present invention, excellent green compact density, excellent relative density of the green compact, excellent sintered body density, and excellent relative density of the sintered body are achieved. In addition, the dimensional changes before and after sintering are much smaller than in the Comparative Examples**. The superior properties obtained using the process of the present invention are not disclosed or suggested by JP5071206A and Inculet et al, either alone or in combination.

TABLE I

Sample No.		Composition (% by mass)	Compaction pressure (MPa)	Ejection Force (MPa)	Green Compact			Metallic Sintered Body				Note
					Green-compact Density (g/cm ³)	Relative Density (%)	Outside Dia. after Ejection (mm)	Sintered-body Density (g/cm ³)	Relative Density (%)	Dimension Change before and after Sintering (%)		
Ex.	1-1	Pure Ti	588	3.5		89.2	23.059	4.325	95.9		-2.60	
	1-2		784	1.9	4.193	93.0	23.061	4.384	97.2		-1.59	
	1-3		980	2.4	4.292	95.2	23.065	4.451	98.7		1.37	
	1-4		1176	2.5	4.364	96.8	23.070	4.496	99.7		-1.11	
	1-5		1372	2.6	4.391	97.4	23.075	4.501	99.8		-0.87	
	1-6		1568	2.2	4.422	98.0	23.079	4.505	99.9		-0.60	
	2-1	Ti-6Al-4V	784	0.9	3.991	91.1	23.065	4.403	99.3		-3.26	Mixture Powder of Pure Ti Powder and Alloy Powder
	2-2		1176	0.5	4.201	95.9	23.071	4.407	99.4		-1.61	
	2-3		1568	0.5	4.285	97.8	23.081	4.412	99.5		-0.96	
	3-1	Ti-6Al-4V +6TiB ₂	784	5.1	3.956	90.2	23.072	4.332	97.4		-3.04	Mixture Powder of said Mixture powder and Hard-particle Powder TiB ₂ : 6% by mass
	3-2		1176	3.6	4.143	94.3	23.078	4.395	98.8		-2.06	
	3-3		1568	2.7	4.234	96.5	23.083	4.412	99.2		-1.46	
	4-1	Pure Al	392	0.3	2.613	96.8	22.997	-	-		-	
	4-2		588	0.7	2.656	98.4	22.992	-	-		-	
	4-3		784	0.7	2.672	99.0	22.994	-	-		-	
	4-4		980	0.7	2.682	99.4	22.994	-	-		-	
	4-5		1176	0.8	2.686	99.5	22.993	-	-		-	
	4-6		1372	0.8	2.667	99.8	22.994	-	-		-	
	4-7		1568	0.5	2.667	99.8	22.995	-	-		-	
5-1	Al-6Zn-2Mg-1.5Cu	588	1.3	2.616	93.4	23.014	-	-		-	Equivalent to JIS A7475	
5-2		980	1.1	2.741	97.9	23.029	-	-		-		
5-3		1568	1.4	2.794	99.8	23.038	-	-		-		
Comp. Ex.	C1-1	Pure Ti	294	8.0	3.209	71.2	23.068	4.235	93.9		-9.58	Room-temp. Compaction
	C1-2		441	16.3	3.521	78.1	23.075	4.290	95.1		-6.94	
	C1-3		588	24.1	3.728	82.9	23.082	4.300	95.3		-4.95	
	C2-1	Pure Al	392	4.1	2.583	95.7	23.056	-	-		-	Room-temp. Compaction
	C2-2		588	5.7	2.615	96.9	23.057	-	-		-	
	C2-3		784	6.5	2.640	97.8	23.059	-	-		-	

Only when all claimed conditions (including the warm pressurizing) are satisfied, the ejecting force can be decreased substantially.

For example, as for warm pressurizing, there is the description that “the alcohol-based solvents evaporate instantaneously so that it is possible to form a uniform lubricant film with ease” in [0068] of the specification.

Further, new **Claim 36** has been added which relates to a process for compacting a green compact, comprising:

applying a higher fatty acid-based lubricant to an inner surface of a die;

filling a raw material powder whose major component is an active metallic element into the die;

compacting the raw material powder by warm pressurizing to make a green compact; and

ejecting the green compact from the die;

whereby the resulting green compact has a high density;

wherein the active metallic element is titanium or aluminum;

wherein, when the active metallic element is titanium, a green density being an apparent density of the green compact is 85% or more of a true density determined by a composition of the raw material powder; and

wherein, when the active metallic element is aluminum, a green density being an apparent density of the green compact is 90% or more of a true density determined by a composition of the raw material powder.

Regarding **Claim 36**, it has been the technical common knowledge that it is impossible to form raw material powders comprising an active metallic element such as Ti and Al by high pressures at industrial level. This is because galling occurs on the inner

surface of dies instantaneously or the inner surface of dies is roughened when such high-pressure compacting is carried out. Moreover, it is because the resulting green compacts cannot be ejected from dies. In addition, very expensive dies cannot be used even after one and only high-pressure compacting operation so that a great loss might arise. See paragraph [0011] of the specification.

In addition, the green compacts have a low density because the pressure cannot be increased. For example, when green compacts comprise a Ti powder, the green compacts have a density which is only 80% or less of the true density. See paragraph [0012] of the specification.

Moreover, when Ti powders are formed conventionally by pressuring using an internal lubrication method, a dewaxing step is required additionally before the resulting green compacts are sintered in vacuum. In addition, since the major components of the lubricants used in this instance, such as hydrogen, nitrogen and carbon, are likely solve in Ti, internal lubrication methods are unpreferable. See paragraph [0013] of the specification.

Another concern is the low dimensional accuracy of the green compacts. See paragraph [0014] of the specification.

In case of Al powders there is an additional concern that when Al powders are mixed with lubricants and are formed thereafter, it is impossible to dewax sufficiently because the dewaxing temperature of the lubricants is close to 500 °C approximately, the sintering temperature of the resulting green compacts.

JP5071206A and Inculet et al do not recognize the specific requirements necessary for Ti and Al containing metal powders.

However, the process according to the present invention, as set forth in Claim 36, gives excellent green compact density, excellent relative density of the green compact, excellent sintered body density, and excellent relative density of the sintered body. In

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addition, the dimensional changes before and after sintering are much smaller. See the Examples and Comparative Examples.

Therefore, the rejection of Claims 1-26 and 29 under 35 U.S.C. § 103(a) over JP5071206A (JP'206) in view of Inculet et al is believed to be unsustainable as the present invention is neither anticipated nor obvious and withdrawal of this rejection is respectfully requested.

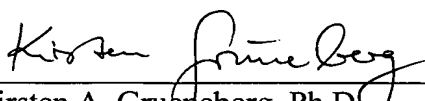
Furthermore, all claims were commonly owned by Kabushiki Kaisha Toyota Chuo Kenkyusho at the time the present invention was made.

This application presents allowable subject matter, and the Examiner is kindly requested to pass it to issue. Should the Examiner have any questions regarding the claims or otherwise wish to discuss this case, he is kindly invited to contact Applicants' below-signed representative, who would be happy to provide any assistance deemed necessary in speeding this application to allowance.

Respectfully submitted,

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